Assignment for SP226 Due 03/10/00 Name _____
Chapter 19

2 • The temperature change of two blocks of masses m_A and m_B is the same when they absorb equal amounts of heat. It follows that the specific heats are related by
(*a*) $c_A = (m_A / m_B)c_B$.
(*b*) $c_A = (m_B / m_A)c_B$.
(*c*) $c_A = c_B$.
(*d*) none of the above.

3 • The specific heat of aluminum is more than twice that of copper. Identical masses of copper and aluminum, both at 20°C, are dropped into a calorimeter containing water at 40°C. When thermal equilibrium is reached,
(*a*) the aluminum is at a higher temperature than the copper.
(*b*) the aluminum has absorbed less energy than the copper.
(*c*) the aluminum has absorbed more energy than the copper.
(*d*) both (*a*) and (*c*) are correct statements.

6 • How many calories must be supplied to 60 g of ice at -10°C to melt it and raise the temperature of the water to 40°C?

8 •• A 50-g piece of aluminum at 20°C is cooled to −196°C by placing it in a large container of liquid nitrogen at that temperature. How much nitrogen is vaporized? (Assume that the specific heat of aluminum is constant and is equal to 0.90 kJ/kg K.)

13* • The specific heat of a certain metal can be determined by measuring the temperature change that occurs when a piece of the metal is heated and then placed in an insulated container made of the same material and containing water. Suppose a piece of metal has a mass of 100 g and is initially at 100°C. The container has a mass of 200 g and contains 500 g of water at an initial temperature of 20.0°C. The final temperature is 21.4°C. What is the specific heat of the metal?

15 •• A 200-g piece of ice at 0°C is placed in 500 g of water at 20°C. The system is in a container of negligible heat capacity and is insulated from its surroundings. (*a*) What is the final equilibrium temperature of the system? (*b*) How much of the ice melts?

72 • After a potato wrapped in aluminum foil has been baked in an oven, it is taken out and its foil removed. The foil cools much faster than the potato. Why?

73* • True or false:

(*a*) The heat capacity of a body is the amount of heat it can store at a given temperature.

(*b*) When a system goes from state 1 to state 2, the amount of heat added to the system is the same for all processes.

(*c*) When a system goes from state 1 to state 2, the work done on the system is the same for all processes.

(*d*) When a system goes from state 1 to state 2, the change in the internal energy of the system is the same for all processes.

(*e*) The internal energy of a given amount of an ideal gas depends only on its absolute temperature.

(*f*) A quasi-static process is one in which there is no motion.

(*g*) For any material that expands when heated, C_p is greater than C_v.

86 •• At very low temperatures, the specific heat of a metal is given by $c = aT + bT^3$ For the metal copper, $a = 0.0108$ J / kg K^2 and $b = 7.62 \times 10^{-4}$ J / kg K^4. (*a*) What is the specific heat of copper at 4 K? (*b*) How much heat is required to heat copper from 1 to 3 K?

98 •• An insulated cylinder is fitted with a movable piston to maintain constant pressure. The cylinder initially contains 100 g of ice at –10°C. Heat is supplied to the contents at a constant rate by a 100-W heater. Make a graph showing the temperature of the cylinder contents as a function of time starting at $t = 0$, when the temperature is –10°C, and ending when the temperature is 110°C. (Use $c = 2.0$ kJ / kg K for the average specific heat of ice from –10 to 0°C and of steam from 100 to 110°C.)

25* • Can a system absorb heat with no change in its internal energy?

26 • In the equation $Q = \Delta U + W$ (the formal statement of the first law of thermodynamics), the quantities Q and W represent
(*a*) the heat supplied to the system and the work done by the system.
(*b*) the heat supplied to the system and the work done on the system.
(*c*) the heat released by the system and the work done by the system.
(*d*) the heat released by the system and the work done on the system.

28 • If 400 kcal is added to a gas that expands and does 800 kJ of work, what is the change in the internal energy of the gas?

29* • A lead bullet moving at 200 m/s is stopped in a block of wood. Assuming that all of the energy change goes into heating the bullet, find the final temperature of the bullet if its initial temperature is 20°C.

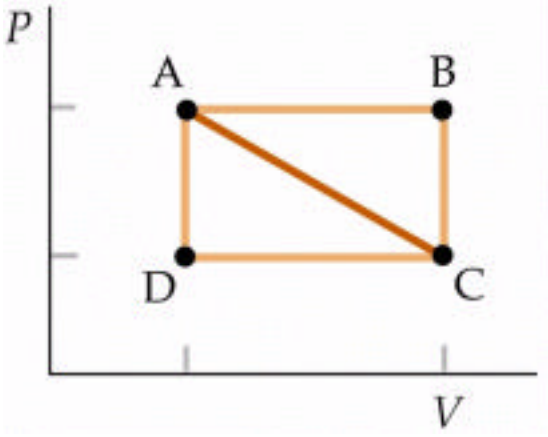
34 •• On a cold day you can warm your hands by rubbing them together. (*a*) Assume that the coefficient of friction between your hands is 0.5, that the normal force between your hands is 35 N, and that you rub them together at an average speed of 35 cm/s. What is the rate at which heat is generated? (*b*) Assume further that the mass of each of your hands is approximately 350 g, that the specific heat of your hands is about 4 kJ/kg K, and that all the heat generated goes into raising the temperature of your hands. How long must you rub your hands together to produce a 5-C° increase in their temperature?

35 • A real gas cools during a free expansion, though an ideal gas does not. Explain.

36 • An ideal gas at one atmosphere pressure and 300 K is confined to half of an insulated container by a thin partition. The partition is then removed and equilibrium is established. At that point, which of the following is correct?
(*a*) The pressure is half an atmosphere and the temperature is 150 K.
(*b*) The pressure is one atmosphere and the temperature is 150 K.
(*c*) The pressure is half an atmosphere and the temperature is 300 K.
(*d*) None of the above.

96 •• One mole of an ideal monatomic gas is heated at constant volume from 300 to 600 K. (*a*) Find the heat added, the work done by the gas, and the change in its internal energy. (*b*) Find these same quantities if the gas is heated from 300 to 600 K at constant pressure.

38 • A gas changes its state reversibly from A to C (Figure 19-16). The work done by the gas is
(*a*) greatest for path A → B → C.
(*b*) least for path A → C.
(*c*) greatest for path A → D → C.
(*d*) the same for all three paths.



In Problems 39 through 42, the initial state of 1 mol of an ideal gas is $P_1 = 3$ atm, $V_1 = 1$ L, and $U_1 = 456$ J, and the final state is $P_2 = 2$ atm, $V_2 = 3$ L, and $U_2 = 912$ J.

39 • The gas is allowed to expand at constant pressure to a volume of 3 L. It is then cooled at constant volume until its pressure is 2 atm. (*a*) Show this process on a *PV* diagram, and calculate the work done by the gas. (*b*) Find the heat added during this process.

42 •• The gas is heated and is allowed to expand such that it follows a straight-line path on a *PV* diagram from its initial state to its final state. (*a*) Show this process on a *PV* diagram, and calculate the work done by the gas. (*b*) Find the heat added during this process.

45* •• One mole of an ideal gas initially at a pressure of 1 atm and a temperature of 0°C is compressed isothermally and quasi-statically until its pressure is 2 atm. Find (*a*) the work needed to compress the gas, and (*b*) the heat removed from the gas during the compression.

47 • The heat capacity at constant volume of a certain amount of a monatomic gas is 49.8 J/K. (*a*) Find the number of moles of the gas. (*b*) What is the internal energy of the gas at $T = 300$ K? (*c*) What is the heat capacity of the gas at constant pressure?

51 •• A diatomic gas (molar mass M) is confined to a closed container of volume V at a pressure P_0. What amount of heat Q should be transferred to the gas in order to triple the pressure? (Express your answer in terms of P_0 and V.)

54 •• One mole of a monatomic ideal gas is initially at 273 K and 1 atm. (*a*) What is its initial internal energy? (*b*) Find its final internal energy and the work done by the gas when 500 J of heat are added at constant pressure. (*c*) Find the same quantities when 500 J of heat are added at constant volume.

56 • When an ideal gas is subjected to an adiabatic process,
(*a*) no work is done by the system.
(*b*) no heat is supplied to the system.
(*c*) the internal energy remains constant.
(*d*) the heat supplied to the system equals the work done by the system.

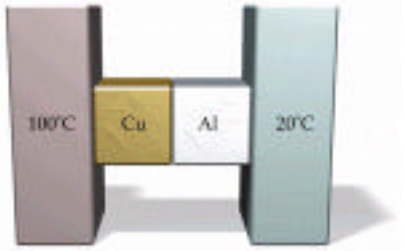
58 • An ideal gas at a temperature of 20°C is compressed quasi-statically and adiabatically to half its original volume. Find its final temperature if (*a*) $C_V = \frac{3}{2}nR$ and (*b*) $C_V = \frac{5}{2}nR$.

60 •• Half a mole of an ideal monatomic gas at a pressure of 400 kPa and a temperature of 300 K expands until the pressure has diminished to 160 kPa. Find the final temperature and volume, the work done, and the heat absorbed by the gas if the expansion is (*a*) isothermal, and (*b*) adiabatic.

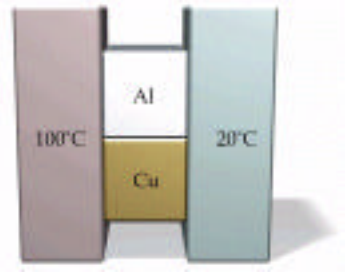
63 ••• A hand pump is used to inflate a bicycle tire to a gauge pressure of 482 kPa (about 70 lb/in^2). How much work must be done if each stroke of the pump is an adiabatic process? Atmospheric pressure is 1 atm, the air temperature is initially 20°C, and the volume of the air in the tire remains constant at 1 L.

105* ••• Prove that the slope of the adiabatic curve passing through a point on the *PV* diagram for an ideal gas is γ times the slope of the isothermal curve passing through the same point.

Ch21-29* •• Two metal cubes with 3-cm edges, one copper (Cu) and one aluminum (Al), are arranged as shown in Figure 21-15. Find (*a*) the thermal resistance of each cube, (*b*) the thermal resistance of the two-cube system, (*c*) the thermal current *I*, and (*d*) the temperature at the interface of the two cubes.



Ch21-30 •• The cubes in Problem 29 are rearranged in parallel as shown in Figure 21-16. Find (*a*) the thermal current carried by each cube from one side to the other, (*b*) the total thermal current, and (*c*) the equivalent thermal resistance of the two-cube system.



Ch21-38 • The heating wires of a 1-kW electric heater are red hot at a temperature of 900°C. Assuming that 100% of the heat output is due to radiation and that the wires act as blackbody radiators, what is the effective area of the radiating surface? (Assume a room temperature of 20°C.)

Ch21-39 •• A blackened, solid copper sphere of radius 4.0 cm hangs in a vacuum in an enclosure whose walls have a temperature of 20°C. If the sphere is initially at 0°C, find the rate at which its temperature changes, assuming that heat is transferred by radiation only.

Ch21-60 •• A copper-bottomed saucepan containing 0.8 L of boiling water boils dry in 10 min. Assuming that all the heat flows through the flat copper bottom, which has a diameter of 15 cm and a thickness of 3.0 mm, calculate the temperature of the outside of the copper bottom while some water is still in the pan.